STUDY ON THE FROST RESISTANCE OF DIFFERENT KINDS OF CONCRETE UNDER STEAM CURING

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1.INTRODUCTION

Mineral admixtures such as fly ash and blast furnace slag have been used for concrete materials from view points of the reduction of environmental impact as well as the enhancement of concrete properties. However, the strength of concretes with fly ash and blast furnace slag at early age is not comparable to that of normal concrete in case when these admixtures are used for partial replacement of Portland cement. Accordingly, the period of curing needs to be longer. In this way cares for curing method are necessary to lead bring about enhanced properties that fly ash concrete and blast furnace slag concrete can have. On the other hand, precast concrete is made in a factory where adequate quality control in the manufacturing process can be achieved. Therefore, it is considered that fly ash concrete and blast furnace slag concrete which are made as precast concretes will bring their ability into full play.

In this research the resistance against frost damage has been studied for fly ash concrete and blast furnace slag concrete. Freezing and Thawing test has been conducted and the relative dynamic modulus of elasticity and the mass loss were measured.

2.EXPERIMENTAL METHODOLOGY

2.1 SPECIMEN PREPARATION

Three kinds of concretes were mixed and tested in this experiment, namely fly ash concrete (FA), blast furnace slag concrete (BB) and early strength concrete (H) [1]. Fly ash used in this study conforms to JIS A 6201 Type II. Blast furnace slag conforms to JIS A 6206 in which the class of the specific surface area is 4000. For all concretes high early Portland cement was employed. The density and absorption of coarse aggregate are 2.64g/cm^2 and 1.69% respectively, and fine aggregate are 2.68g/cm^2 and 1.29%, respectively. The mix proportion was determined by considering design strength and given in Table 1

2.2 CURING METHODS

Steam curing is adopted in which the maximum temperature is kept at 65℃ for 4 hours followed by decreased to 20℃ for 15 hours. After the steam curing, specimens are cured in the air for 13 days under RH 60±5% and 20±2℃.

2.3 COMPRESSIVE STRENGTH

The size of the specimen is φ100×200, and the curing methods are steam curing and standard curing. The compressive strength of the specimens was measured on 28 days of standard curing, 14 days of steam curing. The compression strength results are shown in Fig. 1.

2.4 FREEZING-THAW TEST

Specimen size is 100mmx100mmx400mm. After curing, specimens were under dry storage. Then the Freezing-thawing test started at 21 days. The Freezing and thawing test was conducted based on JIS A1148 Method of test for resistance of concrete to freezing and thawing.

3. RESULTS AND DISCUSSION

As shown in Fig.1. after 14 days of steam curing, the compressive strengths of FB and H are slightly larger than that of BB. Compared with the standard curing of 28 days, the H and FB specimens of steam curing were slightly less than the standard cured in compressive strength. The strength of BB in two curing conditions is relatively obvious.

Table 1 Mixture properties

Series	Slump flow (cm)	Air content (%)	Water (kg/m^3)	Water binder ratio (%)	Cement (kg/m^3)	Fly ash (kg/m^3)	Blast furnace slag (kg/m^3)	Sand (kg/m^3)	Grave (kg/m^3)	Density (kg/m^3)
H	60±5	6.2	160	40.0	400	—	—	838	966	3.14
FB		5.8	154	35.0	352	88	—	800	959	2.31
BB		6.2	164	35.0	234	—	234	781	937	2.91

Keywords: Frost resistance, Ash fly concrete, Freeze-thaw test, blast furnace slag
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When the fly ash concrete is subjected to steam curing, the strength of fly ash concrete will be enhanced by the stimulation of alkaline substances of hydration products. However, BB is obviously less effective than FB when it is generated by alkaline stimulation. It is supposed to the cement content of BB is 30% less than that of FB.

Mass loss result by weight is shown as Fig 1 for H, FB and BB after the Freezing and Thawing test. Within 3 series, it shows larger mass loss for H, rather than FB and BB. As shown in Fig.2, mass loss amount of H is the most, followed by FB and BB. During freezing-thawing cycles, specimens was losing its mass mainly due to surface scaling

As shown in Fig.3, FB has the highest elastic modulus, followed by BB and H. The relative dynamic modulus of elasticity did not show a drop below 60% or even higher than 80% at the ends with 300 cycles. It preserves an adequate internal hardness for all kinds of concrete under steam curing.

It can be concluded that all the specimen made from this mix proportion present a good resistance against 300 cycles FT action, with the result that the durability parameter is over 80%.

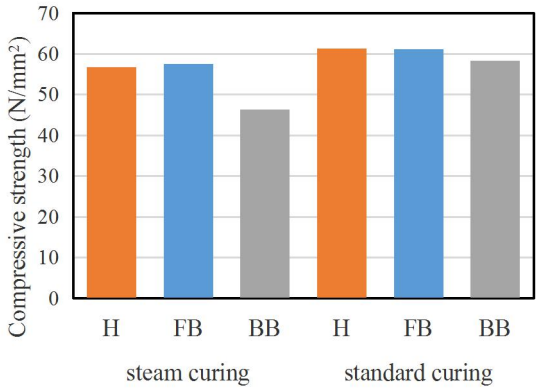

Fig.1 compressive strength for H, FB, BB

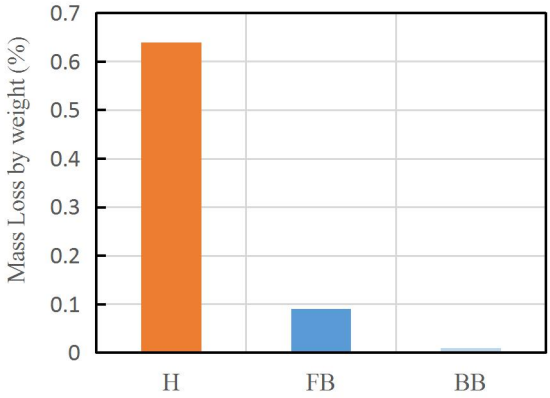

Fig.2 Mass loss by weight for H, FB, BB

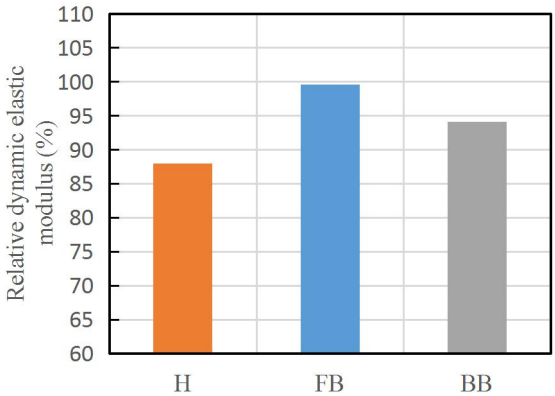

Fig.3 Relative dynamic elastic modulus

4. CONCLUSIONS

Normal concrete with high early strength cement under steam curing showed weak frost resistance against the scaling, while blast furnace slag concrete and fly ash concrete showed little surface scaling. Relative dynamic modulus of elasticity was over 80% for all kinds of concretes tested in this research. Therefore, it indicates that FB and BB have adequate frost durability against freeze-thaw cycles.

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REFERENCE

Hou Yong and T. Sugiyama, Frost resistance of steam cured fly ash concrete based on CDF-test, E-23, The 74th Japan Society of Civil Engineers Hokkaido branch,2018.